Byproducts as Feed for Livestock

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Byproducts make up about one-third of the poultry ration and about one-seventh of the ration for growing and fattening swine in the United States. They are also important in feeding beef and dairy cattle. Almost every food industry furnishes some byproducts for animal feed, but the most important sources are the milling of grain, the processing of oilseeds, the fermentation of grains and molasses, the manufacture of dairy products, and the slaughter of meat animals.

The byproduct feeds discussed here have been grouped for convenience according to their origin.

WHEN CEREAL GRAINS are processed for human food, part of the grain is removed and becomes a byproduct, which is used mainly in feeds for animals. Most of the grain byproducts have higher levels of protein, fat, and fiber than do the original grains. Some contain more of certain vitamins. The higher protein, fat, and vitamin contents add to their value. The higher fiber content limits their use in feeds for swine and poultry.

When corn is processed to produce degerminated corn meal or hominy for human food, the byproduct is hominy feed. It contains some of the starchy portion, besides the corn germs and the corn bran, which consists of tip caps and outer layers of the kernels.

From the wet milling of corn to produce starch and glucose, the byproducts are the germ (which is usually separated into oil and meal), the gluten meal (mostly gluten), and the gluten feed (containing both gluten and bran).

The gluten meal and, to a less extent, the gluten feed and the oil meal may be regarded as protein supplements. Gluten meal is comparable to the oilseed meals in protein content. The quality of the protein is generally inferior from the nutritional standpoint to that of the oilseed meals, however. Hominy feed, gluten meal, and gluten feed prepared from yellow corn contain carotenoid pigments, and hence have some vitamin A activity. That is not true of the byproducts from white corn.

Corn-gluten feed, corn-gluten meal, and hominy feed are widely used in livestock feeding, especially for dairy cattle.

Gluten feed also serves as a protein supplement in the fattening of beef cattle and sheep. It is not used extensively in rations of swine, although small amounts may be included with other supplements which contain proteins of high biological value. Gluten meal is fed under much the same conditions as gluten feed and is generally considered somewhat more valuable in keeping with its higher protein content. Hominy feed is generally used as a replacement for part or all of the corn in the rations of livestock. It can also replace grain in poultry rations.

Yellow corn-gluten meal is valued as a constituent of the diet of growing chickens because of its carotenoid pigments and its protein content. The pigments provide vitamin A and give the desirable yellow color to the shanks and skin of chickens.

In the milling of wheat to produce flour, the bran layers that cover the outside of the kernel, the aleurone layer just inside the bran layers, and the germ are removed, together with some of the starch portion, which cannot be readily separated from the other fractions. Wheat bran is the coarsest byproduct, having the highest fiber content. The finer byproducts are standard middlings, flour middlings, wheat red dog (mostly derived from spring wheat), and brown shorts, gray shorts, and white middlings (generally derived from winter wheat). All of them, except red dog and white middlings, are higher in fiber than whole wheat. They also exceed whole wheat in protein, thiamine, riboflavin, niacin, and vitamin E.

The wheat byproducts are among our oldest supplemental feeds. Their place in rations is well established. The byproducts with the higher fiber contents are mostly used for cattle, sheep, and horses; those with lower-fiber contents, for swine and poultry. Wheat bran is especially prized as a supplement in the rations of cows and ewes. It has been widely used in feeding horses because of its bulky nature and laxative effects. However, it is considered best to limit the proportion in the feed mixture for horses, or to feed it in large amounts only occasionally. For swine, the various shorts and middlings products, along with wheat red dog, are used most efficiently with tankage, fish meal, and milk byproducts as supplements to corn and other cereal grains. Products like wheat red dog, wheat-flour middlings, and white middlings are useful in the diets of pigs.

All the wheat byproducts mentioned have been widely used in poultry feed, but recently the popularity of low-fiber diets, especially for growing birds, has limited their use. When they are omitted from starting and growing mashes, the addition of synthetic niacin may be necessary.

Oat millfeed, barley feed, and rye feed contain the combined byproduct fractions obtained in the production of oatmeal, pearled barley, and rye flour, respectively. Oat millfeed is high in fiber. The others are similar to the wheat byproducts in composition.

In milling rice for human food, the hulls are first removed, and then the germ and outer layers of the kernel as rice bran. The kernels are polished to remove another fraction known as rice polish, which is much lower in fiber than the bran. Rice bran and rice polish are not so high in protein as are the wheat byproducts, but they are high in fat and become rancid rather readily. They are high in thiamine and niacin, and contain more riboflavin than do whole grains. Buckwheat middlings, obtained in the production of buckwheat flour, are higher in protein than the comparable fractions from wheat.

The principal outlet for oat millfeed is as a feed for cattle, sheep, and horses. As a substitute for part of the grain allowance, it is generally worth somewhat less than half as much as corn and other cereals. In tests with horses doing moderate work, oat millfeed has been used to replace both the hay and the grain portions of the ration.

Barley feed and rye feed are suitable as partial replacements for cereals or other cereal byproducts in rations for cattle, sheep, and swine. In total digestible nutrients, barley feed is at least equal if not superior to barley. The supply of both barley and rye feeds is rather limited, however.

Rice bran is fed to dairy and beef cattle, sheep, and swine. Rice bran and rice polish may be fed to swine only in limited amounts; otherwise, the body fats, or lard, become soft. Large proportions in the diet also tend to produce scours. Rice polish is higher in total digestible nutrients than rice bran, a fact that is worthy of note in feeding cattle and sheep as well as swine. The high content of several of the B vitamins is also noteworthy in the use of the two feeds for swine.

Buckwheat middlings are suitable as both cattle and hog feeds, provided they are used in limited amounts.

None of the byproducts of grains other than corn and wheat has attained more than local importance in poultry feeds, but all except oat millfeed and rice hulls are used.

After the fermentation of grain mash to produce alcohol and the removal of the alcohol by distillation, there remains the stillage, which consists of a watery suspension of the unfermentable portions of the grain, together with yeast. The stillage is usually separated by straining into distillers' grains (light grains), which may be fed wet or dry, and solubles.

The concentrated solubles may be added in whole or in part to the grains and dried to form distillers' grains with solubles (dark grains), or they may be dried to form dried distillers' solubles. Because fermentation removes most of the starch but little of the other constituents of the grains, the byproducts are higher in protein, fat, fiber, and several vitamins than are the original grains. Distillers' grains are valued primarily for their protein, although their contents of fat and vitamins add to their value. The solubles have approximately the same protein and fat contents as the grains, but are valued chiefly as a source of riboflavin, pantothenic acid, and niacin.

Three byproducts of the brewing industry are important as feeds—brewers' dried grains, malt sprouts, and brewers' dried yeast.

Brewers' grains are the residue of the barley after digestion and extraction of most of the starch. Malt sprouts are the roots from the sprouting of the barley during the malting process. Brewers' yeast, which is separated from the mixture after fermentation, is valued primarily as a source of riboflavin, niacin, pantothenic acid, and choline. It is also relatively high in protein.

Byproducts are obtained from the bacterial fermentation of grain or molasses to produce acetone and butyl alcohol. They are designated dried-grain (or molasses) fermentation solubles. By definition of the Association of American Feed Control Officials, they must contain not less than 18 milligrams (about 0.0006 ounce) of riboflavin a pound on the moisture-free basis.

Feeding tests have shown that the distillery byproducts have wide application in the feeding of all classes of livestock. In general, the dried grains and the dried grains with solubles have found their widest use through practical experience in rations for dairy cattle, beef cattle, and sheep.

Although not so high in protein as the oil meals, such as linseed, soybean, and cottonseed, distillers' grains rank well in feeding value. Fed on an equal protein basis, there usually is little choice. Tests by the Nebraska Agricultural Experiment Station, for instance, have shown this to be true in the feeding of soybean meal and distillers' grains to fattening cattle.

Combinations of the two supplements gave indications of some superiority over either one fed alone. The distillery byproducts have had wide use as an ingredient in mixed concentrate feeds for milking cows. Both distillers' solubles and distillers' grains with solubles have been found by the Pennsylvania Agricultural Experiment Station to be excellent ingredients in feed mixtures for calves. In general, the dried grains from corn and wheat have given somewhat better results than the products from rye, presumably because of the higher protein contents.

As a swine feed, distillers' solubles are to be preferred to distillers' grains. Distillers' dried grains with solubles stand between them. The reason is largely explained on the basis of fiber and vitamin content. The proteins, being largely those from the original grains used in the fermentation mashes, are not of so high a quality as those in the animal-protein supplements or in most of the oilseed meals. Distillers' solubles included in the diet at levels of 5 to 10 percent make a significant contribution of vitamin factors to many swine rations, comparable in varying degrees to alfalfa meal, dried whey, and other vitamin-rich supplements.

The product is useful in rations for growing and fattening pigs and for pregnant and lactating sows.

If adequate supplements of other high-quality protein feeds are included, distillers' solubles and distillers' grains with solubles help make up the protein deficit of corn in the ration.

Brewers' grains are predominantly a cattle feed to be used interchangeably with other feeds of similar type as to bulk and crude-fiber and protein contents. Sometimes they are used as a partial replacement for grains in rations for cattle, sheep, and horses.

Dried malt sprouts are used chiefly in mixed feeds for dairy cattle, frequently along with brewers' grains. Brewers' yeast, being primarily a vitamin-rich supplement, is used in swine rations, in dog, fox, and mink foods, and in poultry feeds. The protein content is high and this contribution to diets is often significant. Brewers' yeast also has been used successfully as a cattle feed.

Dried fermentation solubles and dried distillers' solubles are important sources of riboflavin and other water-soluble vitamins for poultry. Dried brewers' yeast is also used for this purpose and, although it does not furnish riboflavin at as low a cost as the solubles, it has some additional value as a source of choline.

Distillers' grains with solubles contribute protein and vitamins to poultry diets, but their high content of fiber limits their use. Dried fermentation solubles and distillers' solubles sometimes produce a laxative effect if fed as 5 percent or more of the diet, especially if the diet contains other ingredients that tend to be laxative. Ordinarily the levels required to supply riboflavin are well below the laxative level.

THE RESIDUES after the removal of most of the oil from soybeans, cottonseed, flaxseed, and peanuts are known as oilseed meals. They are among the most important sources of protein for livestock. The oil is removed either by hydraulic or screw presses or by extraction with organic solvents. All three methods are in general use for processing soybeans, but solvent extraction has not been widely used for the others.

Soybean meal is the only major protein supplement that has been increasing in supply in recent years. The proteins of soybeans and some other legumes differ from most proteins in that they must be heated for maximum value to nonruminants. The heat may destroy antienzymes known to be present or it may improve the availability of the protein or it may do both. In screw-pressing soybeans, heat is unavoidable, but not in solvent extraction. Extracted soybean meal requires a separate heat treatment. Proper processing of either type of meal gives an excellent feed.

Soybean meal has become the leading protein supplement in recent years for nearly all classes of livestock. It is used interchangeably with linseed meal and cottonseed meal in rations for cattle, both dairy and beef, for sheep, and even for horses and mules. For dairy cattle, many feeders prefer expeller- or hydraulic-produced soybean meal to solvent-process meal in concentrate mixtures otherwise low in fat. Tests with fattening beef cattle generally have not shown a significant difference between meals produced by different processes. On the range, pelleted meals have met with favor because of convenience and economy in feeding.

As a protein supplement to corn in feeding swine, soybean meal has met with wide favor. Pigs on pasture grow and fatten efficiently and rapidly on rations of corn and soybean meal, supplemented with ground limestone and salt. In dry lot, inclusion of ground legume hay and an animal-protein concentrate is generally beneficial. Depending on availability, other oilseed meals, such as cottonseed, linseed, and peanut, can be used as replacements for part and sometimes all of the soybean meal.

The proteins of soybean meal have been thought to be much less effective than those of animal byproducts in supplementing the proteins of grains, at least in diets of nonruminants.

We now know that diets composed mainly of grains and soybean meal are deficient in some previously unknown vitamins that are supplied by animal-protein supplements. Vitamin B_{12} is one of these. It is believed to be the one most often deficient in practical diets for poultry. Its presence makes possible the successful rearing of chickens on diets in which all the protein is of plant origin, most of it being supplied by soybean meal and grains. Care must be taken to see that such diets contain adequate contents of riboflavin, calcium, and phosphorus. The quantities of these nutrients in soybean meal are much less than those in the animal-protein supplements. The other oilseed meals are similar to soybean meal in this respect.

Cottonseed meal, like soybean meal, is heated during processing, but for a different reason. Raw cottonseed contains several compounds that are toxic, at least to nonruminants. The one that has received the most study is gossypol. Proper heating reduces toxicity to the extent that such cottonseed meals can serve as the only protein supplement in diets for swine and growing poultry.

Even the highest quality cottonseed meals are not recommended at present for laying hens because the minute, nontoxic levels of gossypol in the ration cause egg yolks to develop a green color in storage.

The proteins of cottonseed meal are generally supposed to be somewhat inferior to those of properly heated soybean meal and animal-protein supplements. This supposed inferiority may be due in part to inadequate vitamin B_{12} in the diets used and to deterioration of cottonseed protein from the heat required for detoxification. A process of solvent extraction now available removes the toxic portions of the seed mechanically, making heating unnecessary. The resulting meal has superior qualities, but it has not yet been produced commercially.

Linseed meal is valued in the diets of cattle, sheep, and swine, not only as a protein supplement but also for its conditioning, appetite-stimulating, and laxative effects. The protein is perhaps somewhat inferior to that in soybean meal as a supplement to corn in swine rations. Accordingly, linseed meal is used most effectively with other oil meal and animal-protein supplements. In fattening beef cattle and lambs, linseed meal is very popular and is widely used as a supplement, either alone or in combination with other protein supplements, for its protein and conditioning values. Much the same is true for fattening dairy cattle.

Linseed meal is toxic to poultry except in very low proportions. The toxicity can be largely eliminated by soaking the meal in water for 24 hours or by adding pyridoxin, one of the B vitamins, to the diet. The reasons for the effect of the vitamin are not known.

Peanut meal, so far as now known, contains no toxic compounds or anti-enzymes and therefore requires no heating or water treatment. It is palatable to all classes of livestock. It is a valuable protein supplement and is high in niacin and pantothenic acid. In the South especially it is widely used as the principal protein supplement to grain feeds, especially in swine feeding. Its wide use for different classes of livestock in areas where it is available is comparable to that of soybean meal in the North.

The protein of peanut meal has been reported as slightly inferior to that of soybean meal for poultry, but the comparison may have been influenced by vitamin B_{12} deficiency.

Oilseed meals produced in small quantities as agricultural byproducts in this country include sunflower-seed meal, sesame meal, safflower meal, rapeseed meal, and hempseed meal. Coconut meal, largely an imported product, is used extensively in feeding dairy cattle and, to a less extent, beef cattle and lambs.

The more important animal byproducts used in feeds are tankage, meat meal, meat and bone meal, blood meal, bonemeal of several types, liver meal, and liver and glandular meal.

Meat scraps, trimmings, offal, and the rejected carcasses are sometimes cooked with steam under pressure in closed tanks to separate most of the fat. The watery portion is removed, concentrated, and returned to the solid portion, which is then dried and designated as tankage. The alternative process is to remove the fat by dry cooking in an open steam-jacketed vessel to produce meat meal. Products that contain more than 4.4 percent of phosphorus are designated tankage with bonemeal or meat and bone meal. The principal animal-protein supplements used in feeds are the materials mentioned, together with fish meal, which is also a byproduct, though not of agriculture.

These animal byproducts contain proteins that are good sources of the amino acids in which grain proteins are deficient. Hence they have long been used to supplement grain rations. They are also good sources of calcium, phosphorus, and niacin, and variable but fairly good sources of riboflavin and vitamin B_{12}. The presence of each of these nutrients adds to the value of the animal byproducts as supplements.

Meat meal, meat and bone meal, and fish meal are widely used in poultry feeds. Tankage, on the other hand, is used primarily as a swine feed. The levels of these products in individual diets have been decreasing in recent years as the level of soybean meal increased. Under the circumstances, for poultry at least, fish meal has come to be regarded as superior to meat meal, because it more effectively supplements a diet composed largely of grains and oilseed meals. For growth and for reproduction the superiority of fish meal is due to its higher content of vitamin B_{12}.

In swine feeding, tankage and meat meal have long been used as the main supplement to corn. These and other animal-protein supplements remain an integral part of the more dependable rations for young, growing pigs and for the breeding herd.

Blood meal is prepared by heating blood until coagulated, pressing out the excess moisture, and drying and grinding the solid residue. It is higher in protein than any of the previously mentioned animal byproducts, but its protein is generally considered to be of poor quality, even though relatively rich in some of the essential amino acids, maybe because some of it is damaged by heat during processing. It is not a good source of niacin, riboflavin, or vitamin B_{12}.

Bonemeal is called raw if it is cooked in water at atmospheric pressure to remove excess fat and meat, steamed if it is cooked with steam under pressure, and special steamed if it is steamed in the process of obtaining gelatin or glue. Bonemeals are valued primarily for their calcium and phosphorus.

Liver meal and liver and glandular meal are described by their names. By definition the former must contain 27 milligrams of riboflavin per pound and the latter 18. Both are valued especially in poultry feeds, not only for their riboflavin but for their vitamin B_{12} and probably other factors now unknown.

THE MILK BYPRODUCTS include skim milk, buttermilk, and whey, each of which is fed in the liquid, condensed, and dried forms.

Skim milk is the low-fat fraction separated from the cream by centrifugal separators. Buttermilk is the byproduct remaining after butter has been produced from cream by churning. It contains slightly more fat than does skim milk. A little more than one-third of the solids of both consist of protein of high quality. Whey is the byproduct remaining after the making of cheese from milk. It is lower in protein than skim milk and buttermilk. All three contain lactose, a sugar which is readily converted by bacteria into lactic acid. All are fed in both sweet and sour forms.

The liquid milk byproducts are fed

principally on the farms where they are produced. The condensed and dried forms are important commercial feedstuffs. Condensed skim milk and buttermilk contain by definition not less than 27 percent of solids and condensed whey contains not less than 62 percent of solids. Both are valued for their protein and for their riboflavin and other water-soluble vitamins. Large amounts of whey are fermented to increase the riboflavin content. The dried product may be sold as dried whey fermentation solubles if it contains not less than 18 milligrams of riboflavin per pound on the moisture-free basis.

All three dried milk byproducts were formerly used in large amounts in poultry feeds, and dried whey is still an important ingredient. The quantities of dried skim milk and dried buttermilk available for animal feeding have decreased greatly in recent years, and their place has largely been taken by soybean meal, to supply the protein, and fermentation byproducts, to supply the vitamins.

Nutritionists generally agree that decreases in availability of milk byproducts on farms for swine feeding have left a void to be met by greater use of other supplements capable of supplying protein of equal quality, along with vitamin factors contained in milk.

AMONG THE MISCELLANEOUS PLANT BYPRODUCTS are molasses, beet pulp, potatoes, and citrus pulp.

Cane molasses and beet molasses are byproducts from the manufacture of sugar from sugarcane and sugar beets. They are the condensed juices remaining after as much sugar as possible has been removed by concentration and crystallization. Both are low in true protein and high in sugar. Both are laxative, beet molasses more so than cane molasses because of its higher mineral content. Both are used commonly in feeds for cattle and rarely in feeds for swine and poultry. They are valued in cattle rations for their nutrients and palatability.

Another byproduct from the manufacture of sugar from sugar beets is beet pulp, the residue after extraction of the sugar-containing juice. On the dry basis, it is low in protein and fat and high in fiber, but its fiber is well digested by ruminants. It is fed either wet or dry, principally to cattle.

The wastes that result from the production and processing of vegetables for canning, freezing, and dehydration include tops of carrots, turnips, and rutabagas; leaves and stems of broccoli, spinach, and kale; and vines of peas and lima beans.

Bean and pea vines, in the form of silage, have been used as feed for cattle. Otherwise the products have not been widely used in animal feeds, although experiments have shown that dehydrated leaf meals of broccoli, turnip, carrot, and kale, and meals from pea vines and lima bean vines can all be used to advantage in diets for poultry. They would be of value primarily for their vitamin A potency, and secondarily for their riboflavin and protein content, and probably for unknown factors. When used in poultry feeds they would replace wholly or in part the alfalfa meal that is commonly used.

Surplus and cull potatoes make satisfactory animal feeds. They are high in starch and low in fat and fiber. Their protein content, on the basis of dry matter, is comparable to that of the whole grains. They should be cooked before being fed to poultry or swine. They may be fed raw to ruminants, sometimes ensiled with hay or dry corn fodder, but also when fresh, preferably after chopping. Dehydrated potatoes may be a partial substitute for grain in livestock feeds, including those for swine and poultry if the drying temperature is high enough for thorough cooking.

Surplus and cull sweetpotatoes also are dehydrated and used to feed animals. They are low in protein, fat, and fiber, but high in starch and in vitamin A potency. Dehydrated sweetpotatoes may be used as a partial substitute for grain in diets for cattle, sheep, swine, and poultry.

Peel, seeds, and pulp are left in large quantities from the canning of citrus juices and other citrus products. This byproduct, known collectively as citrus pulp, is fed to ruminants, sometimes fresh and sometimes ensiled or dried. The juice may be pressed from the pulp and concentrated to make citrus molasses, which is used at low levels in concentrate mixtures for cattle.

Apple pomace is the byproduct from expressing juice from apples. It may be fed to cattle fresh, as silage, or dry.

Tomato pomace consists of the skins, pulp, and crushed seeds that remain after manufacture of tomato juice. It is high in protein, fat, and fiber, and has been fed successfully to swine in the wet form. Dried tomato pomace is a common constituent of dog foods.

Research on animal nutrition includes a continual search for new byproducts to use in feeds and for better ways of combining byproducts with other feedstuffs into rations that give a better balance of nutrients and thereby improve the efficiency of use of feeds by livestock. Changes in manufacturing methods for producing byproduct feeds may affect the content of specific nutrients and thereby necessitate a reevaluation of the feed and its place in the ration. The search for new feeds becomes more important as byproducts are transferred from the list of feedstuffs to the list of human foods. Thus in the past decade dried skim milk has largely disappeared from animal feeds to become a constituent of human foods where it commands a higher price.

Cost is important in determining the value of a byproduct in animal feeding. Assembly costs are nearly always borne by the primary product. Sometimes there is no practicable means of disposing of the byproduct except by processing, and then even the costs of processing are charged to the primary product.

The list of byproduct feeds has increased year by year. The identification and classification of the new feeds is an important item in their marketing and use. For the past 40 years the Association of American Feed Control Officials has been describing and defining feeds. The terminology adopted by the association, which is followed generally by the feed industry and by users of the products, is used here.

The byproduct feeds defined by the association include many not discussed here. Some are derived from nonagricultural sources, such as whale meal, crab meal, and fish solubles. Others are derived from agriculture but are too new to warrant consideration here.

Among them are ramie leaf meal, the poultry byproduct meal, extracted penicillin meal, extracted streptomyces meal, dried milk albumin, and dried torula yeast. Each year new byproducts resulting from research and technological development are defined and described by the association, become available to feed manufacturers and feeders, and make their contribution to an efficient livestock industry. Increased use of byproducts reduces costs of animal production and the competition of livestock with humans for our food supply.

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The composition of byproduct feedstuffs

Cereal-grain byproducts

Feedstuffs	*Moisture*	*Crude protein*	*Ether extract*	*Crude fiber*	*Ash*	*Nitrogen-free extract*	*Calcium*	*Phosphorus*	*Carotene*	*Thiamine*	*Riboflavin*	*Niacin*	*Pantothenic acid*	*Choline*
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*mg/lb.*	*mg/lb.*	*mg/lb.*	*mg/lb.*	*mg/lb.*	*mg/lb.*
Barley feed	7.9	15.0	4.0	13.7	4.9	54.5	0.03	0.41	0.2	......	......	......	......	......
Buckwheat middlings	12.4	28.0	6.6	5.3	4.6	43.1	......	......	......	......	......	......	......	......
Corn bran	10.0	10.0	6.6	8.8	2.1	62.5	.03	.14	......	2.0	6.8	......	......	......
Corn-germ meal	7.0	20.8	9.6	7.3	3.8	51.5	.05	.59	......	8.2	1.6	14.1	5.0	726
Corn-gluten meal (yellow)	8.0	43.0	2.7	3.7	2.2	40.4	.10	.47	10.0	......	1.1	13.6	6.3	......
Corn-gluten feed (yellow)	9.5	27.6	3.0	7.5	6.0	46.4	.11	.78	1.1	.5	2.5	39.9	......	......
Corn-oil meal	8.7	22.1	6.8	10.8	2.2	49.4	.06	.62	.2	9.1	3.0	20.4	1.2	......
Hominy feed (yellow)	9.5	11.2	8.3	6.3	2.9	61.8	.03	.44	......	......	6.8	8.0	......	......
Oat hulls	5.8	4.3	1.9	30.8	6.5	50.7	.09	.12	......	.5	1.2	......	......	......
Oatmeal	8.9	16.5	4.8	3.6	2.3	63.9	.08	.43	......	2.2	.5	7.0	5.0	685
Oat millfeed	6.9	6.3	2.2	27.9	6.0	50.7	.20	.22	......	......	......	......	......	......
Rice bran	8.8	12.8	13.8	12.2	12.2	40.2	.10	1.84	......	10.4	1.4	163.0	17.9	......
Rice hulls	6.5	2.1	.4	44.8	21.9	24.3	.08	.06	......	.5	......	......	......	......
Rice polish	10.0	12.4	13.2	2.8	7.6	54.0	.03	1.52	......	9.1	9.5	235.0	46.0	572
Rye feed	10.2	15.6	3.2	4.3	4.0	62.7	......	.59	......	......	......	......	......	......
Rye middlings	9.5	16.7	3.7	5.5	4.4	60.2	......	......	......	1.5	1.0	7.8	10.5	......
Sorghum-gluten feed	9.1	25.2	3.8	7.1	7.3	47.5	......	......	......	......	......	......	......	......
Sorghum-gluten meal	8.6	41.0	4.9	3.3	2.5	39.7	......	......	......	......	......	......	......	......
Wheat bran	9.4	16.4	4.4	9.9	6.4	53.5	.10	1.14	1.1	3.6	1.2	126.5	13.2	648
Wheat-flour middlings	10.4	18.8	4.0	4.2	3.3	59.3	.09	.80	......	6.0	.8	42.4	4.5	......
Wheat germ	9.5	31.9	9.1	3.3	5.2	41.0	......	......	......	11.4	2.3	27.2	9.9	1765
Wheat red dog	11.1	18.3	3.4	2.3	2.2	62.7	.12	.83	......	9.7	1.6	25.1	6.2	......
Wheat shorts, brown	10.8	17.8	4.8	5.8	4.0	56.8	......	......	......	......	......	55.1	......	......
Wheat shorts, gray	11.0	17.5	4.4	5.4	4.1	57.0	.08	.86	.1	......	1.3	44.2	......	......
Wheat standard middlings	10.4	17.0	4.3	5.4	3.9	59.0	.09	.90	1.4	7.5	1.1	56.1	7.1	......
Wheat white middlings	10.9	15.6	3.7	2.4	2.2	65.2	......	......	......	......	......	39.3	......	......

The composition of byproduct feedstuffs—Continued

Distillery, brewery, and yeast byproducts

Feedstuffs	*Moisture*	*Crude protein*	*Ether extract*	*Crude fiber*	*Ash*	*Nitrogen-free extract*	*Calcium*	*Phosphorus*	*Carotene*	*Thiamine*	*Riboflavin*	*Niacin*	*Pantothenic acid*	*Choline*
Brewers' dried grains:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*mg-lb.*	*mg-lb.*	*mg-lb.*	*mg-lb.*	*mg-lb.*	*mg-lb.*
18–23 percent protein	7.9	20.7	7.2	17.6	4.1	42.5	0.16	0.47	......	......	0.6	31.5	......	....
23–28 percent protein	7.7	25.4	6.3	16.0	4.3	40.3	.16	.47	......	......	......	......	......	....
Distillers' dried grains:														
Corn	6.0	27.6	8.7	12.5	2.4	42.8	.10	.45	0.8	0.7	1.3	17.4	2.7	74
Milo	6.9	40.8	13.1	11.8	1.6	25.8	......	......	......	.3	1.3	25.0	2.6	79
Rye	6.5	20.9	6.4	14.4	2.3	49.5	......	......	......	.7	1.8	8.9	2.6	....
Wheat	7.0	30.4	6.6	13.4	2.2	40.4	.06	.42	.5	.8	1.8	38.2	3.1	....
Distillers' dried grains with solubles:														
Corn	7.3	29.1	9.0	9.5	3.8	41.3	......	......	.5	.8	3.0	36.5	5.0	206
Milo	4.2	32.8	9.7	12.1	3.7	37.5	......	......	......	.6	2.0	28.0	5.7	141
Rye	......	......	......	......	......	......	......	......	......	......	3.8	......	......	....
Wheat	7.4	32.9	5.6	9.4	4.8	39.9	.15	.68	1.1	......	5.6	......	......	....
Distillers' dried solubles:														
Corn	7.2	27.4	7.6	4.3	7.5	46.0	.43	1.30	.3	3.2	6.1	64.5	10.4	339
Milo	6.9	29.4	5.9	3.5	7.7	46.6	......	......	......	2.2	4.9	60.0	11.1	352
Rye	6.5	35.5	.6	2.4	7.8	47.2	......	......	......	1.2	6.3	18.7	14.1	....
Wheat	7.5	30.1	2.0	8.0	8.0	50.4	.35	1.51	1.0	3.0	5.3	103.5	17.5	....
Distillers' (potato) dried residue	3.9	25.9	4.1	13.0	7.4	45.7	......	......	......	......	......	......	......	....
Fermentation solubles:														
Grain	7.3	35.8	6.2	8.1	6.2	36.4	......	......	......	......	......	......	......	....
Molasses	4.5	28.0	1.2	1.8	12.6	51.9	......	......	......	......	......	......	......	....
Malt sprouts	7.2	24.6	1.8	13.9	7.5	45.0	......	......	......	......	5.5	25.4	......	....
Yeast, brewers' dried	5.5	47.2	.9	3.0	7.3	36.1	......	......	......	31.2	14.1	216.7	50.0	....
Yeast, feed, dried	6.0	52.6	4.3	17.2	7.7	12.2	.07	1.55	......	10.0	30.0	159.0	......	....

							Oilseed meals							
Coconut meal	9.9	20.6	8.4	10.2	6.3	44.6	......	......	......	......	......	......	......	....
Cottonseed meal:														
36–39 percent protein	7.5	37.2	5.8	14.4	5.4	29.7	0.30	1.20	0.1	6.1	4.1	20.4	6.4	1525
39–43 percent protein	7.4	41.0	6.5	10.8	6.2	28.1	.23	1.18	.1	6.1	4.1	20.4	6.4	1525
43–48 percent protein	7.0	43.9	6.6	10.5	5.8	26.2	.20	1.03	.1	6.1	4.1	20.4	6.4	1525
Linseed meal:														
31–34 percent protein	9.6	33.1	5.8	7.9	5.6	38.1	.39	.90	.1	2.5	1.3	20.3	3.2	....
34–37 percent protein	9.1	35.4	5.7	7.9	5.6	36.4	.38	.86	.1	2.5	1.3	20.3	3.2	....
37–40 percent protein	9.1	38.6	5.7	7.6	5.6	33.4	.36	.82	.1	2.5	1.3	20.3	3.2	....
40–43 percent protein	8.5	41.2	5.7	7.3	5.3	32.0	.34	.77	.1	2.5	1.3	20.3	3.2	....
Peanut meal:														
38–43 percent protein	6.4	41.6	7.2	16.0	4.4	24.4	.10	.50	.1	2.6	1.6	96.6	24.7	1025
43–48 percent protein	6.7	45.1	7.2	14.2	4.6	22.2	.17	.55	.1	2.6	1.6	96.6	24.7	1025
Sesame meal	9.8	37.5	14.0	6.3	10.7	21.7	......	......	......	......	1.5	......	4.5	....
Soybean meal:														
38–43 percent protein (exp.-hyd.)	7.8	42.0	6.0	6.1	5.7	32.4	.24	.63	.1	6.1	1.6	16.0	6.4	1330
43–48 percent protein (exp.-hyd.)	8.2	44.4	5.7	6.0	5.9	29.8	.26	.62	.1	6.1	1.6	16.0	6.4	1330
43–48 percent protein (solvent)	8.7	46.0	1.1	5.7	6.0	32.5	.25	.68	.1	6.1	1.6	16.0	6.4	1330
Sunflower-seed meal	4.6	52.8	4.5	4.1	6.5	27.5	......	....	....	......	......	141.6	19.5	....
							Animal and milk byproducts							
Blood meal	8.8	83.1	1.1	0.8	5.3	0.9	0.28	0.22	......	......	1.6	17.1	2.4	....
Bonemeal:														
Raw	6.7	25.2	3.3	1.4	62.1	1.3	24.20	11.50	......	......	......	......	......	....
Steamed	3.1	6.2	2.2	1.3	83.6	3.6	30.00	13.90	......	......	......	......	......	....
Special steamed	2.7	11.1	6.5	1.7	75.1	2.9	27.00	13.20	......	......	......	......	......	....
Buttermilk, dried	5.5	34.3	7.0	.3	9.4	43.5	1.32	.93	......	1.2	13.7	7.7	18.6	....
Liver meal	7.3	65.2	14.9	1.9	8.0	2.7	......	......	......	......	22.0	......	47.5	....
Liver and glandular meal	6.5	65.1	16.5	1.5	4.7	5.7	......	......	......	......	20.6	......	......	....

The composition of byproduct feedstuffs—Continued

Animal and milk byproducts—Continued

Feedstuffs	*Moisture*	*Crude protein*	*Ether extract*	*Crude fiber*	*Ash*	*Nitrogen-free extract*	*Calcium*	*Phosphorus*	*Carotene*	*Thiamine*	*Riboflavin*	*Niacin*	*Pantothenic acid*	*Choline*
Meat and bone scrap:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*mg-lb.*	*mg-lb.*	*mg-lb.*	*mg-lb.*	*mg-lb.*	*mg-lb.*
42–48 percent protein	5.8	45.6	14.0	2.4	28.9	3.3	9.63	5.00	......	......	1.5	17.8	1.2	....
48–53 percent protein	5.7	50.3	10.4	2.0	29.3	2.3	9.34	5.07	......	......	1.9	21.4	1.5	....
53–58 percent protein	6.5	55.5	9.1	2.2	25.1	1.6	8.28	4.04	......	......	2.1	21.8	1.8	....
Meat scrap:														
48–53 percent protein	6.4	50.8	10.4	3.2	26.0	3.2	7.80	4.17	......	......	2.3	23.4	1.7	....
53–58 percent protein	6.1	55.3	9.7	2.3	24.4	2.2	7.68	4.00	......	......	2.5	30.6	2.3	602
58–63 percent protein	7.2	60.0	9.6	2.3	19.8	1.1	5.72	3.02	......	......	2.7	29.0	2.1	....
Skim milk, dried	4.7	35.8	1.0	.1	8.8	49.6	1.34	.99	......	1.6	8.4	4.8	13.2	722
Tankage:														
53–58 percent protein	7.3	56.0	9.6	2.2	23.3	1.6	7.49	3.86	......	......	.7	13.6	.8	....
58–63 percent protein	6.3	60.3	9.1	2.0	20.7	1.6	6.37	3.28	......	......	1.2	19.4	1.2	1047
Whey, dried	6.7	12.8	.6	.2	10.1	69.6	.73	.66	......	.8	10.9	8.3	23.9	....
Miscellaneous byproducts														
Apple pomace	78.6	1.3	1.2	3.7	0.6	14.6	0.02	0.01	......	......	......	......	......	....
Beet pulp, dried	9.2	9.3	.8	20.0	3.2	57.5	.66	.06	......	0.2	0.1	1.4	......	....
Citrus pulp	9.5	6.5	3.7	12.8	7.4	60.1	2.08	.11	......	......	......	......	......	....
Molasses, beet	20.5	9.7	......	......	9.1	60.8	.30	.04	......	......	......	22.0	......	....
Molasses, cane	24.0	3.1	......	......	6.8	66.1	.35	.06	......	.4	1.0	21.3	17.9	390
Pea vine meal	8.0	13.5	3.2	22.5	8.1	44.7	......	......	......	......	......	......	......	....
Potato meal	10.8	8.8	.4	2.3	4.4	73.3	......	......	......	......	......	......	......	....
Sweetpotato meal	9.1	3.6	.8	3.1	4.2	79.2	......	......	......	......	......	......	......	....
Tomato pomace	6.3	27.0	13.2	25.8	4.8	22.9	......	......	......	......	......	......	......	....